Consensus Summary Report

A. Small Coastal Shark Complex
B. Finetooth Shark
C. Blacknose Shark
D. Atlantic Sharpnose Shark
E. Bonnethead Shark

Prepared by the SEDAR 13 (Small Coastal Sharks) Review Panel for:

NOAA/NMFS Highly Migratory Species Management Division

Edited by Joseph E. Powers for

SEDAR 13 (Small Coastal Sharks), 6–10 August 2007
Panama City, FL

Executive summary

The SEDAR 13 Review Panel met from 6 to10 August 2007, in Panama City, FL. A Chair and 3 CIE reviewers made up the panel. The three NMFS scientists responsible for the assessments summarized the outputs from the Data and Assessment Workshops succinctly and accurately.

Overall, the data used in the assessment of the **Small Coastal Shark complex** *were considered the best available at the time, and the assessment of the status of the complex is considered adequate given the data available. However, because the species which comprise the complex have all been assessed separately (as recommended in previous assessments), the Review Panel based its recommendations on the species-specific results rather than on the aggregated small coastal complex results.*

For **finetooth sharks***, the population model and resulting population estimates are considered the best possible given the data available. Stock status was determined from the results of a range of general production model fits reflecting the Panel's uncertainty about life history parameters, catches and indices of abundance. Results indicated that the stock is not overfished and overfishing is not occurring. While it is reasonable to conclude that the stock is not presently overfished, the impact of index choice when so few are applicable (2002 assessment results versus current assessment results) suggest that management should be cautious.*

For **blacknose sharks***, appropriate standard assessment methods based on general production models and on age-structured modeling were used to derive management benchmarks. The current assessment indicates that spawning stock fecundity (SSF) in 2005 and during 2001-2005 is smaller than SSFmsy, i.e. that blacknose shark are overfished. The estimate of fishing mortality rate in 2005 and the average for 2001-2005 is greater than Fmsy, and the ratio is substantially greater than 1 in both cases. Thus, overfishing was occurring and is likely still occurring. However, because of uncertainties in indices, catches and life history parameters, the status of blacknose shark could change substantially in the next assessment in an unpredictable direction.*

For **Atlantic sharpnose sharks***, the Panel concluded that the data used for the analyses were treated appropriately. The assessment does not show the SSF index falling below the threshold over the period considered, but the ratio index shows an almost continuous decline towards it. While it is reasonable to conclude that the stock is not presently overfished, the fact that F is close to, but presently below, Fmsy (i.e. overfishing is not occurring) means that if F is maintained, the stock will continue to decline toward the SSF threshold and will fall below it as F fluctuates around Fmsy. It would therefore be desirable to distinguish between targets and thresholds.*

In terms of **bonnethead sharks***, the Panel accepts the conclusion of the current assessment that it is likely that SSF is greater than SSFmsy, i.e. that bonnethead are not overfished. The estimate of fishing mortality rate in 2005 is less than Fmsy, thus overfishing was not occurring in that year. However, fishing mortality rates in the recent past have fluctuated above and below Fmsy. Thus, there is some probability that fishing mortality rates in 2006 and 2007 have been or will be in excess of Fmsy.*

Recommendations for future research contained in the Data and Assessment Workshop reports were endorsed, and others were added by the Panel. The report closes with a few comments on process, for future consideration.

1. Introduction

1.1 Time and Place

The SEDAR 13 (Small Coastal Sharks) Review Workshop met in Panama City, FL, from 6 to 10 August 2007.

1.2 Terms of Reference for the Review Workshop

1. *Evaluate the adequacy, appropriateness, and application of data used in the assessment.*

2. *Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.*

3. *Recommend appropriate estimates of stock abundance, biomass, and exploitation (if possible).*

4. *Evaluate the methods used to estimate population benchmarks and management parameters; recommend values for management benchmarks (MSY, Fmsy, Bmsy, MSST, MFMT) and provide declarations of stock status*

5. *Evaluate the adequacy, appropriateness, and application of methods used to project future population status; recommend appropriate estimates of future stock condition (if possible).*

6. *Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty, considering input data, model fit, and model configuration. Ensure that the implications of uncertainty with regard to status determinations and management values are clearly stated.*

7. *Ensure that the assessment results are clearly and accurately presented in the Stock Assessment Report and that the reported results are consistent with Review Panel recommendations.*

8. *Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.*

9. *Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and whether a benchmark or update assessment should be considered.*

10. *Prepare a Consensus Report summarizing the peer review Panel's evaluation of the reviewed stock assessments and addressing these Terms of Reference. (Drafted during the Review Workshop with a final report due two weeks after the workshop ends.)*

1.3 List of Participants

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1.4 Review Workshop working papers

An impressive quantity of documentation was provided before the meeting by the facilitator. Much of this pertained to material provided to either the Data Workshop or Assessment Workshop for each of the review stocks. No new literature or working papers were provided at the meeting**.**

2. Terms of Reference

2.1 Background

The Review Workshop is the third meeting in the SEDAR process, and this situation pertained to all stocks reviewed during SEDAR 13. The Panel records that the Terms of Reference set for Data Workshops and Assessment Workshops for the Small Coastal Shark complex (SCS) and the four "stocks" were fully met, at least to the extent feasible, a notable achievement given that data for assessing such species are traditionally (worldwide) very poor.

The Panel was impressed by the quantity and quality of the work that had gone into the assessments. The presentations were well structured and clear, and the information provided through the presentations, and in response to questions, gave a sound basis for the Panel's subsequent deliberations and conclusions.

2.2 Review of the Panel's deliberations

The deliberations on each species are presented in the form of responses to the terms of reference listing some of the issues and concerns that were raised in discussions, followed by relevant comments on and conclusions from the discussions, and suggestions for future research (the last two non-prioritized).

In several instances the issues to be discussed under the terms of reference were generic to all of the stocks being assessed. Therefore, a general response to those issues is presented in a separate section and referred to under each stock. Specific comments are included in the stock-specific section.

Finally, the 10th term of reference requests a Consensus Summary Report. The report herein is the Review Panel's response to that term of reference. Thus, it is not discussed further in the body of the report.

2.2.1 Note on MFMT and MSST

The Review Panel understands that the current Fishery Management Plan established a Maximum Fishing Mortality Rate Threshold (MFMT) and a Minimum Stock Size Threshold (MSST) for the small coastal complex as a whole, but that currently, these thresholds have not been formally adopted for the individual species. It is the Panel's understanding that for the complex, MFMT=Fmsy and MSST=(1-M)*Bmsy (where M equals the instantaneous natural mortality rate). Therefore, for purposes of presentation the Review Panel is tacitly defining MFMT and MSST as in the FMP definitions for the complex.

2.2.2 General Response to Terms of Reference

7. Ensure that assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.

This term of reference is difficult to meet for the Review Panel. The Stock Assessment Report has been written already and approved when the Review Panel meets. It can be modified if errors in facts, in calculations, or in interpretation are discovered but it would not be appropriate for the Review Panel to modify the Assessment Report for style, clarity or consistency with the Review Panel recommendations.

8. *Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.*

The SEDAR process is a well thought out transparent consensus building process. Given the diversity of data and information sources, particularly for indices of stock size and biological parameters, putting the data together is a major task and it is appropriate to do so through a data workshop where all interested parties can participate. Similarly, analyzing the data through an Assessment Workshop whose tasks are to provide estimates of population parameters and trends as well as estimates of management benchmarks is appropriate. The Review Workshop, whose tasks are to evaluate the assessment methods and results and to provide the status declaration, with support from the assessment teams, provide an independent neutral evaluation of the methods, results and status determination.

The Data Workshop appears to have met the large majority of its terms of reference completely. Term of reference 3 was almost completely met, but the evaluation of how well the indices of stock size represented fishery and population conditions was not complete. For most stocks, at least some indices indicate conflicting trends over time, some increasing and some decreasing, while other indices were variable over time but showed no trends. The three conditions cannot adequately represent the conditions of the stock, assuming that the stock unit is appropriately defined, unless various geographical components of a stock complex behave differently over time. It is not clear if the selection of indices could be further refined at the Data Workshop or whether it would be more appropriately done at the Assessment Workshop, but it is clear that the selection of indices to be used in the modeling has to be further refined.

The Assessment Workshop appears to have successfully and completely met all its relevant terms of reference except that it did not provide research recommendations.

The process as implemented in SEDAR 13 could be improved by structuring the reports and the presentations more explicitly according to the terms of reference. It would also help to provide more details of the exploratory runs, perhaps in a working paper so that the choice of final run can be better understood.

9. *Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and whether a benchmark or update assessment should be considered.*

General research recommendations from the Data Workshop Report relevant to all species include the following

1. Re-evaluate life history in Atlantic Ocean, spanning the range of the stock.
2. Expand research efforts directed towards tagging of individuals in south Florida and Texas/Mexico border to get better data discerning potential stock mixing.
3. Develop empirically based estimates of natural mortality

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Additionally, the following recommendations provided in no particular order, deal with the collection of catch rate series data.

The Review Panel encourages the continuation of the fishery-independent surveys reviewed. Some series that were not useful at this time may prove useful in the future with the inclusion of more data and series that were recommended for use at this time may improve with the additional information.

If significant methodological changes are planned, it would be wise to have an overlap period between the gear, design, or vessel changes to all for calibration and quantification of those changes. This will allow for the time series to be maintained as one entity.

As indicated above, there were no recommendations from the Assessment Workshop.

2.2.3. *Small Coastal Shark Complex*

The small coastal shark complex originally included seven species of sharks: finetooth, blacknose, Atlantic sharpnose, bonnethead, smalltail, angel and Caribbean sharpnose sharks. This category was created because catch and catch per unit effort data were aggregated over species, as some fisheries did not distinguish between species when reporting data. Also, the complex included species with similar life history characteristics. The original assessment of the complex was done on the aggregate data, recognizing the risks of assuming that the status of the individual species within the complex may not be reflected by the status of the complex as a whole. Thus, the original management measures were directed at this complex.

In 1999 smalltail, angel and Caribbean sharpnose sharks were removed from the small coastal shark complex, for management purposes, and put in a prohibited species category. This left four species in the complex: finetooth, blacknose, Atlantic sharpnose and bonnethead sharks.

Subsequently, a number of improvements have occurred in the data. Data sets of species-specific catches have been obtained and historical catches by species reconstructed. Additionally, individual research projects have provided species-specific information on relative abundance trends. This allowed individual analyses of the four species within the small coastal shark complex. Of these four species, bonnethead and Atlantic sharpnose sharks comprise approximately 94% of the catch. Thus, the small coastal shark complex is now essentially the aggregation of those two species.

With the development of species-specific data bases, SEDAR 13 used species-specific models for analysis. Nevertheless, for continuity purposes the species aggregated assessments were continued. However, it is the Review Panel's view that the aggregate analysis of the complex is unlikely to accurately reflect the status of every individual species in the complex and therefore it should not be viewed in isolation from the species-specific assessments. The aggregated results were not inconsistent with the assessment results on bonnethead and Atlantic sharpnose sharks, in particular. Therefore, the results of alternative forms of analysis were examined for differences and similarities in their structure and results, leading to advice on those species. This does not preclude that management of small coastal sharks as a complex may continue into the future; however, the scientific advice now focuses on the individual species within that complex. The Review Panel supports the Assessment Workshop decisions to provide assessment and advice on a species by species basis, rather than on the complex.

2.2.4. *Finetooth Shark*

Terms of reference

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.

Life History Data

Finetooth sharks (*Carcharhinus isodon*) comprise only a small fraction of the catch (1%) of small coastal sharks and the data on their life history, abundance, and catch is consequently sparse. Some aspects appear to be relatively well understood. Even though life history estimates such as maximum age, and modest tag returns indicated some isolation between the East Coast (EC) and the Gulf of Mexico (GOM), the data workshop stated that they would treat finetooth sharks as a single stock. Thus these data were combined to yield a growth curve that was later used to convert size to age, and scaled up to the catch. Similarly because data is sparse, estimates of fecundity and the assumption of biennial reproduction relies on data from the EC. If in fact the groups are separate, subsequent management decisions could leave one at risk. In contrast, mortality is estimated in a risk-averse manner, by estimating survivorship from maximum age data using a variety of well-known techniques. When applying such methods to finfish, the 95th percentile of age is usually chosen to eliminate spurious outliers. However in a data sparse situation this approach would be less helpful. As done now, it provides a conservative estimate of M which may give an optimistic perception of stock status. Another important parameter that is estimated from life-history tables is the intrinsic rate of population increase, r. The value of r is -0.056 indicating a future decline in population size, based on standard calculations from the available data. Based on calculations of the steepness of the recruitment function, this value of r was rejected as being unreasonable. Such a result could arise from misspecification of fecundity-at-age or incorrectness in the assumption of biennial recruitment and these assumptions are worthy of further review.

Catch and Survey Data

Data on CPUE from fishery-independent and fishery-dependent sources is similarly sparse for finetooth sharks. Numbers of landed sharks are calculated as landed weight divided by average weight. The numbers of finetooth sharks are calculated directly by applying their proportion to the total catch weight. The finetooth commercial catch comes from nets, longlines, and handlines in descending order (SEDAR-13-DW). They are also caught recreationally in less than half the amount of the commercial catch since the 1990's. Unlike the other species under review, they are not taken in the shrimp bycatch because their distribution is closer to the shore. The methods for obtaining catch estimates and numbers are reasonable for this species. Commercial catch data have been collected since 1995 and recreational catch data since 1982. These estimates are also reasonable for this species.

Catch rates were standardized using a GLM approach, which is a well-accepted method of standardization. The CPUE time series that provide data for finetooth include the fishery-dependent gillnet observer series, and three fishery-independent surveys including the Panama

City gillnet, Texas, and South Carolina COASTSPAN gillnet. These series occur throughout the range but are not continuous or overlapping. The choice of these indices is reasonable given that they provide the best coverage in time or space for this species.

2. Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.

Given that finetooth sharks are a small portion of the catch and data on their population dynamics is sparse, there is a limited range of stock assessment models that can be applied to them. The Assessment Workshop chose to use two stock production models (SPM), a Bayesian surplus production model and a WinBUGS Bayesian state-space surplus production model. These models allow incorporation of priors. Note that both also rely on an assumption of logistic growth in the population, hence density dependence. A negative *r* precludes the use of these surplus production models. Given a negative value for *r* obtained from finetooth life history, the Data and Assessment Workshops had to assume another value for *r* to run these models. The 2002 value was chosen. The 2002 value is a reasonable choice, but by necessity doesn't reflect the most recent data on this species. When data are sparse it is easy to be in such a situation, but it also indicates that model results should be viewed with caution and that further research is necessary to resolve the issue with *r*.

Both models use standard and well-recognized methods and are frequently used for stock assessments in data-poor situations. Input data to these models starts in 1976, corresponding to the beginning of the Texas series, with the fishery-dependent index starting in 1983. The indices were assigned equal weight in fitting the models. While there are understandable reasons for this, it ignores the fact that some indices provide better coverage or are more adequately designed to assess a given species. Nonetheless, results of the model didn't change substantially when the series were weighted by the inverse CV. With a stock that is data-poor, such as finetooth sharks, other alternate models can be used in conjunction with the surplus production models to check the results. Such models could include size- or stage-based matrix models that incorporate density dependence or simple delay-difference models. Given the problems with *r* for finetooth, such an approach would prevent an overly optimistic view of stock status. This is particularly important because the series are variable and don't show a long-term trend, and without much contrast, SPMs are difficult to fit.

Modeling included sensitivity analyses to test for the effects of CPUE weighting, extension of the catch series back to 1950, adding addition CPUE series, and a lower *r* value (r=0.02). None of the sensitivity simulations gave appreciably different results than obtained with the base model. Additionally, when further analyses were done upon the Review Panel's request (including use of a multivariate t, a uniform prior on r), there were no substantial change in results from the base case. One concern raised during the review was that lognormal priors were used for N_{76}/K, *r*, and C_0, implying that there was some more knowledge of these than was justified. It was suggested that uniform priors be used and simulations be redone. The results of these new simulations were similar to the baseline case, and uniform priors on *r* made little difference.

3. Recommend appropriate estimates of stock abundance, biomass, and exploitation (if possible).

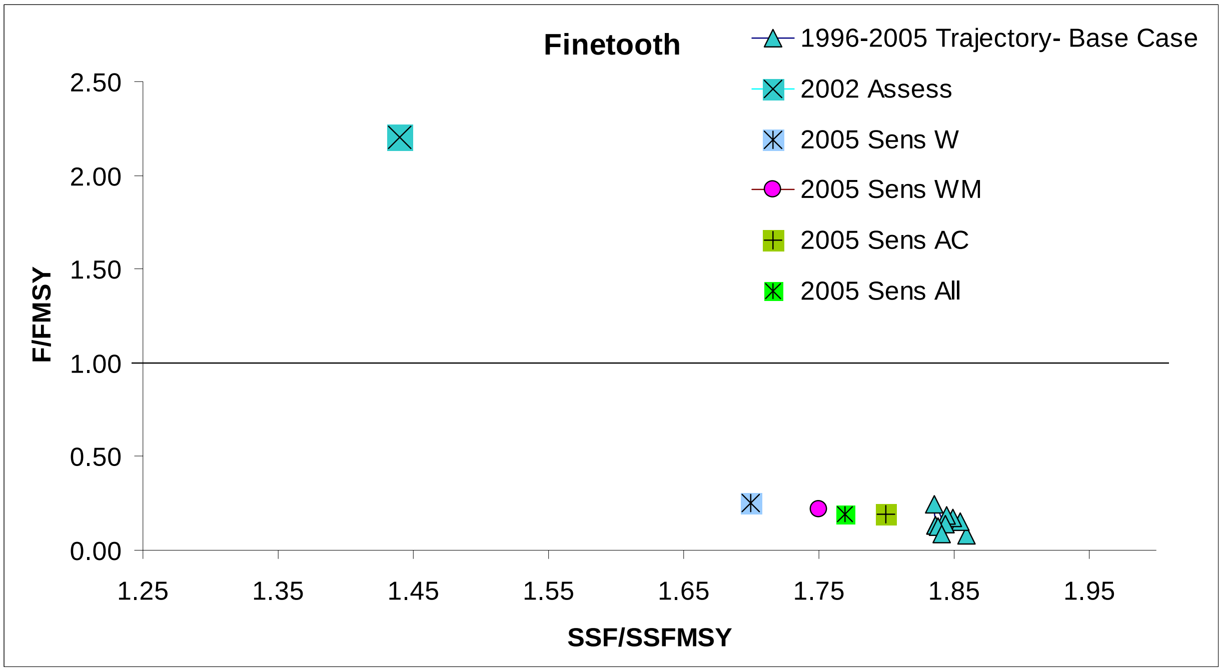
The predicted abundance trend from the surplus production model was relatively flat at approximately 3.7 to 4.1 million. When retrospective analyses were run, these trends were also flat, but differed in magnitude. The reference points of N/N_{msy} were consistently in the range of 1.5 and always above 1. The estimates of F and F/F_{msy} were quite variable from year to year, again reflecting the flat input time series and scarcity of data. However variable, the model rarely estimated F above F_{msy}. Given the constraints mentioned in the previous sections, the model is providing seemingly acceptable estimates.

The Review Panel's concern is that the 2002 assessment showed that there was overfishing in some years, but there is no indication of overfishing in the current assessment. However, it is difficult to compare the two assessments because the 2002 assessment was somewhat *ad hoc* as it included indices based on the choice of one person while the current assessment is based on the collective selection by the Data and Assessment workshops. The differences seem to be due mostly to the change in CPUE indices and the additional few years of catch data. It would be good operating procedure to systematically identify the reasons (differences in data series used, addition of new data, changes in model, or changes in model assumptions) for changes in perception of stock status and stock trends.

4. Evaluate the methods used to estimate population benchmarks and management parameters; recommend values for management benchmarks (MSY, Fmsy, B_{msy}, MSST, MFMT) and provide declarations of stock status.

The methods used to estimate population benchmarks are appropriate for use with surplus production models. B_{msy} and F_{msy} are set as the threshold values in an effort to be precautionary. For finetooth sharks, the estimated values for B fall above 1.0 and for F fall below 1.0. This gives one the feeling that this stock is at least not in decline. However, the change between the 2002 and 2007 assessments due to choice of indices is a cautionary tale. This is a species that is not adequately sampled in the time series of CPUE either from fishery-dependent or fishery-independent indices and small changes in availability or the timing and location of sampling can result in quite different results.

The assessment does not show the biomass index falling below the threshold over the period considered. While it is reasonable to conclude that the stock is not presently overfished and that overfishing is not occurring, the impact of index choice when so few are applicable (2002 versus 2007 assessment results) should result in a cautious management strategy.



5. Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (if possible).

Future population status is projected with the surplus production model using a projected value for the current TAC, no TAC, and double the current TAC. Production models do not account for changes in numbers at age or juvenile survival as would an age-structured model. Thus the projections offer less confidence and less insight. However, given the data scarcity for this species, this is an appropriate method for projections. The projections are adequate in so far as the model input has adequately captured the population dynamics. Again, the lack of data sufficient to result in a problematic *r*, the lack of broad spatial or temporal coverage of the input time series, and the substantial variability in these indices gives concerns in relying too heavily on such population projections. Additionally, the projections are for central tendency only (as medians) and don't capture process error and uncertainty.

6. Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty, considering input data, model fit, and model configuration. Ensure that the implications of uncertainty with regard to status determinations and management values are clearly stated.

Uncertainty has been characterized in a number of ways in the finetooth stock assessment. A simple estimate of uncertainty is provided in summary statistics (CVs) that show the extent of variability in input data. For finetooth sharks, the data paucity is reflected in very high CVs around mean values of abundance, K, MSY, and catch ratios, among others. Another measure of uncertainty that has been provided is the 80% credibility indices around the Bayesian estimates for N, F, and their ratios in the baseline case and in the sensitivity analyses. The uncertainty in time series is not captured as well. Several of the indices are highly variable over their time course, but also express contradictory values at a point in time to other indices. When the model encounters these types of input data it has difficulty discerning trends and estimating parameter values. In some of the assessments, the models were run by excluding subsets of data series and determining if the exclusion changed the results. Although exclusion of series is a good way to evaluate the uncertainty produced by the selection of time series, this isn't feasible in this case because there were only four input time series to begin with and several of these are sparse in coverage over space or time. So one is precluded from measuring the uncertainty in this way. However an indication of the difference that the inclusion of indices can make to assessment of this species is shown between the 2002 and 2007 assessments which gave quite different results.

7 Ensure that assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.

See Section 2.2.2, above.

8. Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.

See Section 2.2.2, above. Also, the review of finetooth shark assessment could have benefited by seeing the exploratory analyses of the life tables that were conducted by the assessment team who were very thorough. It would have given the Review Panel more confidence in the results from the input data.

9. Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and whether a benchmark or update assessment should be considered.

Research recommendations from the Data Workshop Report are given above.

Additionally, the Review Panel has two more recommendations for finetooth shark. The first is to resolve the issue of negative *r* by targeted research on the life history of this species for both the Atlantic Ocean and the Gulf of Mexico. The second is to use an alternate model that is more appropriate to such a data-poor species. This class of model includes length- and stage-based density dependent matrix models or a delay-difference model. The assessment team is to be commended for endeavoring to apply more data-demanding models. However, the Review Panel is concerned that these models may give a misleading sense of confidence that isn't warranted.

Schedule for the next assessment of finetooth: the current stock status indicates that it is not undergoing overfishing and it is not being overfished. It is recommended that no new assessment be undertaken for several years, until such time that basic uncertainties in the data can be resolved; and/or trends in catch or other indices indicate changes in the fishery.

2.2.4. *Blacknose Shark*

Terms of reference

1. *Evaluate the adequacy, appropriateness, and application of data used in the assessment.*

The assessment of blacknose shark (*Carcharhinus acronotus*) cannot be considered a data rich assessment, but adequate and appropriate data were available and they were used properly in the assessment. Data used in the assessment consist of estimates of life history parameters (such as reproductive rate, growth, maturity and natural mortality (M)), catch data and indices of abundance both from fishery independent and fishery dependent sources.

No direct estimates of M are available and values were derived from published methods that make certain assumptions about the relationship between M and observed maximum age, and knowledge about the life history of the animal. The data workshop chose estimates that corresponded to the highest pup survival (i.e. low M). The values chosen appear plausible but the choice of M has a direct bearing on the estimate of MSY and needs to be considered carefully. Consideration should be given to a plausible range of values on M for sensitivity runs.

The number of pups per female is based on observation (SEDAR 13-DW-17).

The Data Workshop agreed on or calculated data on catches by gear and selected stock size indices, both fishery independent and fishery dependent, to be used in the modeling. The Assessment Workshop reviewed the catch estimates and revised them as considered appropriate by reducing anomalously large shrimp by-catches in 1977 and by allowing an exponential increase in the longline catches during 1981 to 1995 instead of a linear increase as agreed by the Data Workshop. Catch estimates come from various sources, but the main source of removals is the by-catch in the shrimp fishery (between 36 and 70 percent of the total since 1993 when the small coastal shark management plan was implemented). Total estimated removals varied between 39,000 and 128,000 sharks between 1993 and 2005, averaging close to 82,500 for the period.

The Data Workshop selected indices to be used in the base case for blacknose sharks, those that should be used in sensitivities runs, and those that were not considered useful indices of blacknose stock size. Some indices are increasing (Panama City gillnet juvenile (not used in surplus production models), gillnet observers, NMFS SE longline) some are decreasing (Panama City gillnet adult, University of North Carolina), while other indices are variable over time showing no trends (Bottom longline observers, South Carolina Dept. of Natural Resources, Mote Marine Laboratory). Except for the Panama City gillnet juveniles and adults, where the differing trends could be explained by a lag in recruitment, the selected indices cannot all adequately represent the conditions of the stock, if the stock unit is appropriately defined, unless various geographical components of a stock complex behave differently over time. In the next scheduled assessment, subsets of consistent indices should be identified and used in assessment models. If one of those subset cannot be objectively chosen as best representing stock trends, the implications for management of using each of the subsets should be evaluated.

In order to provide estimates of gear selectivity for the state space age-structured model (SPASM), length frequency data from samples were aggregated and converted to age. Gear selectivity parameters were then derived by inspection for maximum age of selection and fitting a logistic or dome curve, depending on gear. This is a relatively crude approach which may be adequate for the purpose but it is difficult to judge without more information on the quantity and quality of the data used. The Data Workshop Report does not provide these details. Whether or not this is an important issue depends on how selectivity information is handled in the SPASM model in the future. For the present, the estimates used can probably be considered adequate as the model results are not likely to be very sensitive to the values.

2. *Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.*

Three methods were used to assess blacknose shark, a Bayesian Surplus Production model (BSP), a WinBUGS state-space Bayesian surplus production model, and a State-space age structured production model (SPASM). All methods are documented and have been used before in other assessments. SPASM is designed to estimate both observation error and process error. It was the principal assessment tool used to evaluate blacknose shark stock status. All models allow the incorporation of prior information.

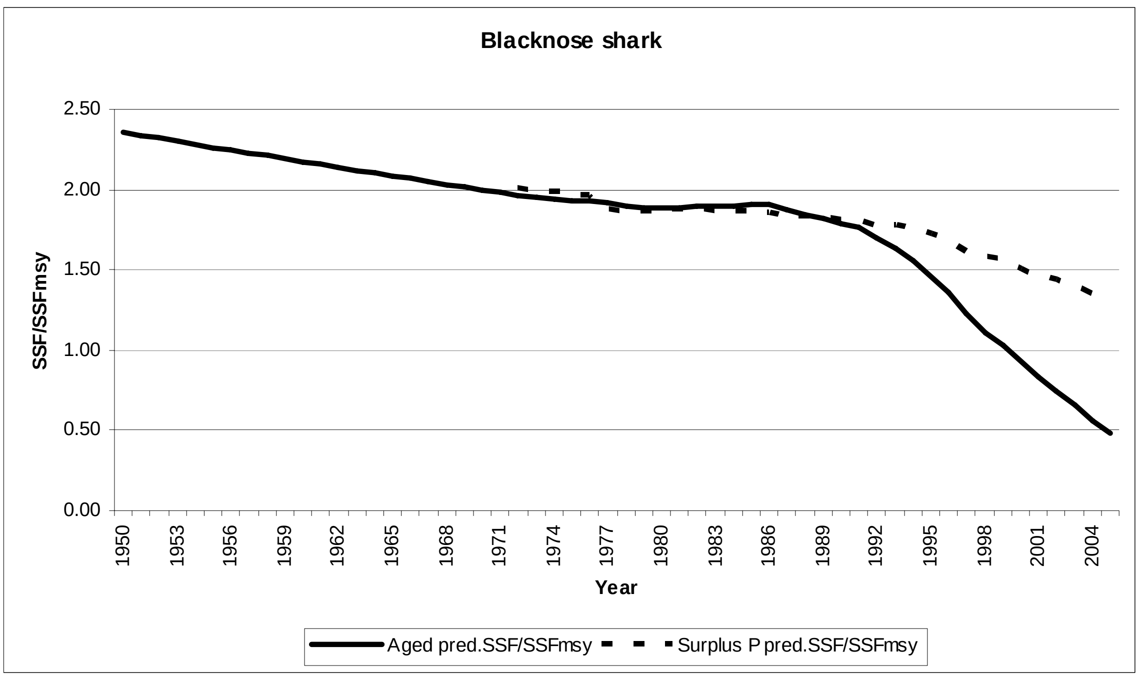
The methods chosen are appropriate for blacknose shark given the data available. The ability to include priors on some of the quantities of interest is important in view of the potentially poor information content in the data, particularly the absence of age structured data. However, care needs to be taken in judging the extent to which choice of priors predetermines the results from the model.

In order to fit the abundance indices that select different age ranges of fish, selectivity parameters were input to the model. These are age-based values that provide catchabilities that in turn mediate between the 'unseen' age-structured population generated in the model and the observed indices. Given that selectivity operates primarily as a size process and most of the age data are derived from length samples, it might be preferable to model selectivity as a size rather than age process. This would enable the model to use length data as observations that might offer it more information to help estimate the population size/age structure.

The Assessment Workshop working documents and Assessment Workshop report adequately describes the pros and cons of each method. The general production approach requires less data, runs more rapidly but is less able to capture the biological characteristics of the species. The age-structured approach is considered a preferable approach when appropriate and sufficient data are available. The Assessment Workshop considered that appropriate and sufficient data were available for the age-structured model and chose it to represent stock trends.

3. *Recommend appropriate estimates of stock abundance, biomass, and exploitation (if possible).*

For blacknose shark, as indicated above, assessments were available using surplus production and age-structured approaches. The Assessment Workshop decided to use the age-structured production model described in SEDAR13-AW-03 as the basis for its assessment because it allowed for the incorporation of age-specific biological and selectivity information which the surplus production models did not. Both approaches used very similar input data and stock size indices, but the age-structured assessment model was able to use a Panama City gillnet juvenile index in addition to the adult series used in the surplus production models. The base surplus production model resulted in population estimates that were approximately 2.5 times larger than those from the age-structured modeling for the first 20 years of the overlapping period but since the early 1990s, the ratio of surplus production estimated numbers to age-structured population numbers has increased. The ratio of spawning stock fecundity to spawning stock fecundity at MSY (Figure below) for both methods have been very similar during 1972 to the early 1990s at about twice the population numbers producing MSY, but since then they have diverged: the surplus production estimates suggest that the stock size is still above that producing MSY while the age-structured results indicate that the stock is at approximately half that producing MSY. The age-structured results are considered more representative of likely stock trends.



Unsurprisingly, because of the divergent trends or lack of trends, neither of the assessment approaches results in good fits to the indices, but the age-structured approach fits almost perfectly to all the catches by gear, except for the by-catch in the shrimp fishery where not all the points are fitted exactly. Figure 4.10 of the Assessment Report shows that the catches and the effort process make by far the largest contribution to the likelihood in the age-structured base assessment model, while the indices contribute less than one tenth the combined contributions of the catches and the effort processes. It is not obvious that the catches are more precisely and more accurately known than at least some of the indices. The Review Panel asked that the model be re-run with more weight given to the indices, but the results were not substantially different, except that the catches were not as well fitted and the indices were only marginally better fitted (again, not necessarily a surprise given that the indices selected either diverge or show no trends). Attempts were made to run the model with effort (and therefore fishing mortality) constrained to change less than in the current parameterization, but it was not possible to achieve a satisfactory run in the time available.

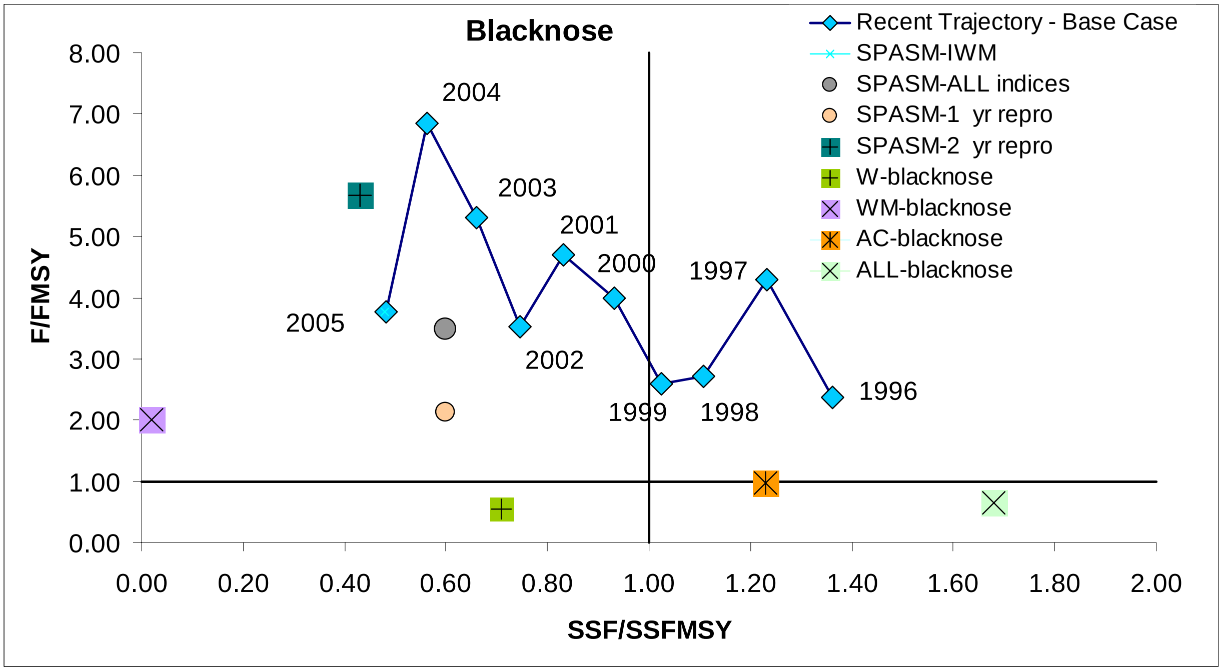
The choice of the age-structured model as the assessment method by the Assessment Workshop is probably appropriate at this stage, but modeling could be improved by developing a length-based model, rather than an age-based one. That would allow fitting yearly indices of stock size at length where the data are sufficient (e.g. Atlantic sharpnose shark). As indicated above, the results of the current modeling approach could change considerably if different subsets of stock size indices were used and if the model was parameterized differently. There is therefore a reasonable probability that the assessment results could change substantially, in an unpredictable direction, in the next assessment.

The base case SPASM assessment produced estimates of the number of blacknose sharks (N), the fecundity of female blacknose sharks (SSF), and the fishing mortality rates throughout the time series (1950-2005). The table below provides the 2005 values and the most recent five year averages for the N, SSF, F and for SSF/SSF_{msy} and F/F_{msy}.

	N	SSF	F	SSF/SSFmsy	F/Fmsy
2005	410,245	223,110	0.245	0.482	3.769
Avg 2001-2005	474,701	262,847	0.314	0.656	4.828

4. *Evaluate the methods used to estimate population benchmarks and management parameters; recommend values for management benchmarks (MSY, Fmsy, Bmsy, MSST, MFMT) and provide declarations of stock status.*

For blacknose shark, appropriate standard methods based on general production models and on age-structured modeling were used to derive management benchmarks. The current assessment indicates that SSF in 2005 and during 2001-2005 is smaller than SSF_{msy}, i.e. that blacknose shark are overfished. The estimate of fishing mortality rate in 2005 and the average for 2001-2005 is greater than F_{msy}, and the ratio is substantially greater than 1 in both cases. Thus overfishing was occurring and is likely still occurring. As indicated above, however, the status of blacknose shark could be substantially changed in the next assessment in an unpredictable direction.



5. *Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (if possible).*

For blacknose shark, projections were calculated because the species is considered overfished and overfishing is considered to be occurring. The projections were done using Pro-2Box (Porch 2003) with F_{2005} for 2006, 50% of F_{2005} for 2007 through 2009 to account for the expected effects of hurricane Katrina and F=0 thereafter when management action could be implemented. Variability in recruitment was modeled by allowing for process error in the spawner-recruit relationship with lognormal recruitment deviations CV = 0.4 and no autocorrelation for 500 bootstraps. The model and assumptions are considered appropriate for blacknose sharks, but the Review Panel is concerned that the projections do not incorporate all sources of uncertainty.

6. *Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty, considering input data, model fit, and model configuration. Ensure that the implications of uncertainty with regard to status determinations and management values are clearly stated.*

As in all modeling exercises, estimates of uncertainty are conditional on the structure of the model, which generally underestimate overall uncertainty. The statistical estimates of variation derived from the fits to the catch and survey indices, depend on a number of structural assumptions.

Uncertainty is characterized in the priors, plots of model fits to the data and likelihood profiles of the principal quantities of interest. Sensitivity analyses also provide some indication of the uncertainty associated with model assumptions. These methods are all standard and appropriate.

The choice of sensitivity runs is limited and was not intended to explore the full range of uncertainty. Given the significance of MSY in the management of fisheries on these stocks it is important to examine sensitivities to those values that influence the calculation of MSY reference points. This will include biological parameters relating to M, maturity, growth, fecundity and the structural assumption about the stock-recruitment curve.

7. *Ensure that assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations.*

See Section 2.2.2, above.

8. *Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.*

   See Section 2.2.2, above.

9. *Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and whether a benchmark or update assessment should be considered.*

Research recommendations from the Data Workshop Report relevant to blacknose are given above.

Schedule for the next assessment of blacknose: the current stock status indicates that blacknose shark is being overfished and that overfishing is occurring. Thus, it would be wise to reassess this stock within two or three years. Users of the assessment results should be aware that major differences in the estimated status could be expected in the next assessment if consistent subsets of stock size indices were used. In the current assessment, the stock size indices used are conflicting, and the assessment model takes an average of all the indices. If separate assessments were done with the indices that indicated increases, those that indicated stability, and those that indicated decreases, this would show greater uncertainty in stock status and stock trends.

2.2.6. Atlantic Sharpnose Shark

Terms of reference

1. Evaluate the adequacy, appropriateness, and application of data used in the assessment.

Life history data

Data used in the assessment consist of estimates of life history parameters (such as reproductive rate, growth, maturity and natural mortality (M)), catch data and indices of abundance both from fishery independent and fishery dependent sources.

No direct estimates of M are available and values were derived from published methods that make certain assumptions about the relationship between M and observed maximum age, and knowledge about the life history of the animal. The data workshop chose estimates that corresponded to the highest pup survival (i.e. low M). The values chosen appear plausible but it important to appreciate that the choice of M has a direct bearing on the estimate of MSY and needs to be considered carefully. Consideration should be given to a plausible upper value on M for sensitivity runs.

The number of pups per female is based on observation and increases with size (SEDAR 13-DW-08). However a fixed value with age was used in the assessment. This may not be important when F is low and the age structure of the stock remains relatively stable as is apparently the case for this stock. However, it might be expected to affect the value of MSY estimated in the model and a sensitivity run to test this needs to be undertaken.

Specific details of the matrix method used to estimate R_0, r, α and z (steepness) are not provided. However, these parameters are only used in the BSP model that is not used as the main assessment and are not material to the principal results.

Catch data

Most of the catch of Atlantic sharpnose shark is taken as bycatch in the shrimp fishery. The remainder is made up from recreational and commercial fisheries. The catch estimates for the shrimp bycatch and the recreational fisheries have been derived from fishery surveys or bycatch sampling and the estimates will inevitably suffer from sampling error. This means that most of the observed catch used in the assessment model is affected by estimation error of unknown magnitude. While this problem needs to be borne in mind it does not mean the estimates are inappropriate. The approach probably does provide the best available estimate of total catch.

Using trends in human population expansion to raise the recreational catch is probably a good and robust covariate for this purpose.

Selectivities

In order to provide estimates of gear selectivity for the SPASM model length frequency data from samples were aggregated and converted to age. Gear selectivity parameters were then derived by inspection for maximum age of selection and fitting a logistic or dome curve, depending on gear. This is a relatively crude approach which may be adequate for the purpose but it is difficult to judge without more information on the quantity and quality of the data used. The Data Workshop Report does not provide these details. Whether or not this is an important issue depends on how selectivity information is handled in the SPASM model in the future. For the present, the estimates used can probably be considered adequate as the model results are not likely to be very sensitive to the values.

Abundance Indices

A large number of abundance indices are available and tabulated in the Data Workshop Report (SEDAR-13-DW). A subset of these indices were selected on the basis of number of years of observations, area coverage and precision. Of these, two fishery dependent surveys and 11 fishery independent surveys were selected. These series appear to conform to conventional standards for fish stock assessment and are appropriate for the purpose.

2. *Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.*

Three methods were used to assess the stock. These were a Bayesian Surplus Production model (BSP), a WinBUGS state-space Bayesian surplus production model, and a State-space age structured production model (SPASM). All methods are documented and have been used before in other assessments. SPASM is designed to estimate both observation error and process error. It was the principal assessment tool used to evaluate stock status. All models allow the incorporation of prior information.

The methods chosen are appropriate for the species concerned given the data available. The ability to include priors on some of the quantities of interest is important in view of the potentially poor information content in the data, particularly the absence of age structured data. However, care needs to be taken in judging the extent to which choice of priors predetermines the results from the model. In the case of the SPASM model, a uniform prior on Virgin Recruitment and a log normal prior pup survival were used. Neither of these could be considered to unduly bias the model results.

In order to fit the abundance indices that select different age ranges of fish, selectivity parameters were input to the model. These are age based values that provide catchabilities that in turn mediate between the ‘unseen’ age-structured population generated in the model and the observed indices. Given that selectivity operates primarily as a size process and most of the age data are derived from length samples, it might be preferable to model selectivity as a size rather than age process. This would enable the model to use length data as observations that might offer it more information to help estimate the population size/age structure. There is likely to be a significant computational overhead in doing this which needs to be traded off against any potential improvement in the model performance.

The indices do not show a consistent trend with some series (e.g. UNC) increasing while others are decreasing (e.g. SEMAP-GOM-EF). The only way the model can account for these opposing trends is through the selectivities of the gears. Given the assumption of population mixing, constant selectivity, and a relatively stable population age structure, the model was unable to account for the observed trends in the indices well. This means the overall stock trajectory is influenced most by the catch and is something of a compromise between the various abundance index trends. During the meeting additional runs considered lower relative weighting to the catches but this made little difference to the results.

It is difficult to know if the inclusion of 13 abundance series is the optimum choice and there may be some value in a more systematic analysis of these series outside the assessment model. A simple preliminary analysis would be to examine the cross correlations to see the extent to which the series measure a common signal. If they don't correlate well, then there is a danger of simply using random numbers in the assessment. This is especially important if inverse variance weighting is used since given the large number of series included, there would be a real danger of arbitrarily giving one series high weight when in reality it bore no resemblance to a real trend. In this regard, the decision to use equal weights for the abundance indices would seem to be a sensible approach.

Catch data by fleet were modified by the Assessment Workshop in two important respects. For BLL catches and discards the development of catches in the pre-observation period was modified from a linear increase to an exponential increase. For the gillnet and handline series the 2003 value was modified to correct for an unexpected spike in the catch which appears to be the result of a miscoded reported catch. These modifications appear to be sensible. In particular the gillnet/handline series is likely to distort the model fit for no good reason without the modification.

A notable feature of the model fit is how close the fitted catches are to the observed values. In effect this is close to treating the catches as exact observations. It means that variability in the catches translates directly into variability in the estimates of annual fishing mortality. There must be a concern that the model does not partition observation error in the catches and process error in the fishing mortality well. This, in itself, does not mean the population trajectory, or fishing mortality estimates are inadequate but it is especially relevant in trying to judge stock status because the most recent estimate of F may not in fact be a good indicator of prevailing F over a medium term (3-5 year) time horizon.

Sensitivity runs considered splitting the SEAMAP series, using inverse weighting, separate Atlantic/Gulf assessments and using alternative models (BSP, Winbugs). With regard to the terminal year (2005) these sensitivity tests do not alter the perception of the stock and hence offer some reassurance about the robustness of the results. However, these runs do not consider sensitivity to the biological parameters that can influence the estimate of MSY, namely M, maturity, growth and fecundity. While there is no reason to doubt the validity of the values used in the assessment, there may be some value in extending the sensitivity runs to examine the influence of the assumed biological parameters on the relative position of the stock to MSY reference points.

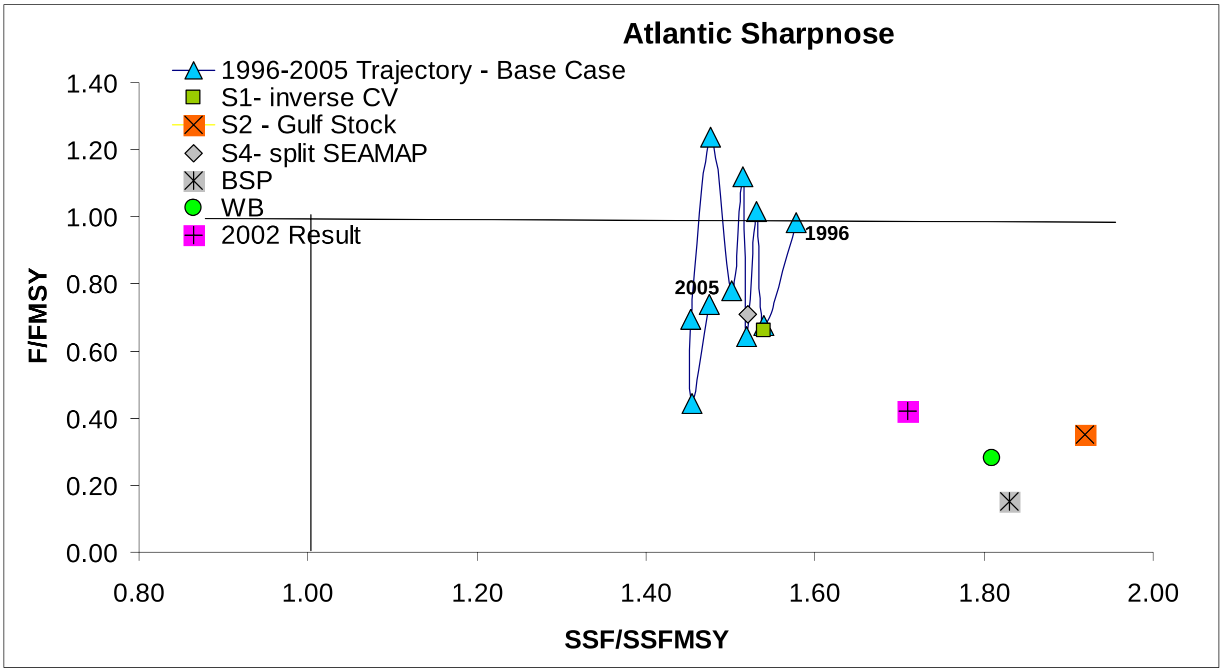
3.Recommend appropriate estimates of stock abundance, biomass, and exploitation (if possible).

The estimates derived from the Base SPASM model should be used to characterize the stock change over time. They give the likely development in stock size and fishing mortality. The preceding section discusses the noisiness of the F estimates and this should be taken into account when both viewing the long term trend and judging the currently prevailing fishing mortality. For the latter, it is probably better to consider the mean value for the most recent 5-10 years as more representative. For projections it is unwise to select single point estimates for the initial conditions. These should be drawn from a distribution. In the case of N_{2005} the probability profile could be used. For F, the distribution could be a taken from the variance of the last 10 annual F values.

4. *Evaluate the methods used to estimate population benchmarks and management parameters; recommend values for management benchmarks (MSY, Fmsy, Bmsy, MSST, MFMT) and provide declarations of stock status.*

The assessment approach adopted for this stock estimates reference points that express the present stock state relative to estimated MSY, ie $F_{current}/F_{msy}$ and (Spawning Stock Fecundity) $SSF_{current}/SSF_{msy}$. This is a desirable choice of reference values as they are relatively insensitive to arbitrary changes in assessments (e.g. revised M, updated catch data etc). The choice of SSF as opposed to the more common SSB appears to be well adapted to the biology of sharks and is likely to be a better measure of reproductive potential than SSB. There is a weakness in respect of the fishing mortality reference point due to the variability in annual estimates of F driven by variability in the catch data. As can be seen in Fig 5.5 of the Assessment Workshop Report, F has periodically exceeded the threshold with no obvious trend. What is clear is that any single year is not representative of the prevailing F. An approach which smoothed out this variability would be desirable. This could be done either by restricting the model fit so that F is smoothed, or simply by taking a mean over recent years. At the Review Workshop phase plots were requested that plotted the reference points over the last 10 years. The plot (Figure below) shows that in the past decade the fishing mortality threshold had been exceeded in 3 years out of 10. This is indicative of the likely proximity of current stock status to an overfishing condition. Thus while the current point estimates for 2005 place the stock in the not overfished/not overfishing status, there may be a modest probability that overfishing is occurring.

The assessment does not show the SSF index falling below the threshold over the period considered, but the ratio index shows an almost continuous decline towards it. While it is reasonable to conclude that the stock is not presently overfished, the fact that F is close to F_{msy} means that if F is maintained, the stock will continue to decline toward the SSF threshold and will fall below it as F fluctuates around F_{msy}. It would therefore be desirable to define thresholds which trigger a management response before such thresholds are reached.



5. *Evaluate the adequacy, appropriateness, and application of the methods used to project future population status; recommend appropriate estimates of future stock condition (if possible).*

The Assessment Workshop considered the stock to be not overfished and that overfishing was not occurring and therefore did not run any forward projections. Given the proximity of F to F_{msy}, its variability and the continuous decline of SSF toward its MSY threshold, there would be some merit in performing a forward projection to evaluate the probability of exceeding the reference points in the medium term. Such projections would need to capture the variability in F and the other major sources of uncertainty. They would provide managers with an indication of developing problems and whether intervention was appropriate.

6. *Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty, considering input data, model fit, and model configuration. Ensure that the implications of uncertainty with regard to status determinations and management values are clearly stated.*

Uncertainty is characterized in the priors, plots of model fits to the data and likelihood profiles of the principal quantities of interest. Sensitivity analyses also provide some indication of the uncertainty associated with model assumptions. These methods are all standard and appropriate. The choice of sensitivity runs is quite limited and perhaps does not explore the full range of uncertainty. Given the significance of MSY in the management of these stocks it is particularly important to examine sensitivities to those values that influence the calculation of MSY reference points. This will include biological parameters relating to M, maturity, growth, fecundity and the structural assumption about the stock-recruitment curve. It would be worth exploring alternative stock recruitment functions as robustness tests.

7. *Ensure that assessment results are clearly and accurately presented in the Stock Assessment Report and that reported results are consistent with Review Panel recommendations*.

This term of reference is difficult to meet for the Review Panel. The Stock Assessment Report is already written and approved. It can be modified if errors in facts, in calculations, or in interpretation are discovered but it would not be appropriate for the Review Panel to modify the Assessment Report for style, clarity or consistency with the Review Panel recommendations.

8. *Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.*

See Section 2.2.2, above.

9. *Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and whether a benchmark or update assessment should be considered.*

See Section 2.2.2, above. Also, recommendations are only made by the Data Workshop. Those of relevance to Atlantic sharpnose are as follows:

a) Coordinate a biological study for Atlantic sharpnose so that samples are made *at least* monthly, and within each month samples would be made consistently at distinct geographic locations. For example, sampling locations would be defined in the northern Gulf, west coast of Florida, the Florida Keys (where temperature is expected to be fairly constant over all seasons), and also several locations in the South Atlantic, including the east coast of Florida, South Carolina, and North Carolina. This same sampling design could be applied to all small coastal sharks.

b) Population level genetic studies are needed that could lend support to arguments for stock discriminations using new loci and/or methodology that has increased levels of sensitivity.

c) Continuation of the fishery-independent surveys reviewed is encouraged. Some series that were not useful at this time may prove useful in the future with the inclusion of more data and series that were recommended for use at this time may improve with the additional information.

All three recommendations have merit but need to be judged on the basis of resources available and the priority/value of the fishery concerned. If the stock can be evaluated as not overfished and where no overfishing is occurring it is doubtful that increasing the level of sampling and research will change the effectiveness of management. It is also necessary to consider the opportunity costs of allocating resources to this species at the expense of other priorities. Recommendation (b) is only worthwhile if there is a capability to manage the two regions as separate stocks and that the fisheries operating in the two areas are sufficiently separate for this to make sense. For example, if vessels can transfer between areas, separate management may not be effective. A desk study using simulation models could be carried out to explore if a two stock approach is desirable, and if so, the more costly genetic study could be initiated.

With regard to (c), such surveys are often extremely costly and before an open ended commitment is made it would be desirable analyse the value of existing surveys and consider whether a more parsimonious approach might serve the purpose of the assessment without the need to support numerous surveys.

Schedule for the next assessment of Atlantic sharpnose: the current stock status indicates that it is not overfished. While in 2005 it was not undergoing overfishing, in several of the previous years it had been. Thus, it would be wise to reassess this stock within two or three years. However, major differences in the status are unlikely to be detected unless, 1) regulations are implemented; 2) data and indices are improved; or 3) catches change.

2.2.7. Bonnethead Shark

Terms of reference

1. *Evaluate the adequacy, appropriateness, and application of data used in the assessment.*

The basic data used in the assessment included catch time series, CPUE and Survey indices, some size frequencies, and growth and reproduction parameters used for estimating vital life history rates.

The catch series included directed catches (recreational and commercial), discards from the recreational catches, and discarded bycatch in the shrimp trawl fishery. Of these, the shrimp trawl bycatch contributed most to the catch (about 80% in numbers). Additionally, the catch series for 1950 (the first year in the assessment model) through 1972 were reconstructed catches based upon average tendencies, rather than year to year variation.

A large suite of survey and CPUE indices were examined and used in the assessment (PC Gillnet adult, PC Gillnet juvenile, Gillnet Observer Program, Everglades series, SEAMAP SA, Texas Gillnet, SC COASTSPAN, SEAMAP GOM (early years), SEAMAP GOM (later years), Mote Marine Lab Gillnet (adult), Mote Marine Lab Gillnet (juvenile), Gillnet logbook). The indices had various spatial coverages from very localized to coast-wide. Additionally, the time span over which the surveys were conducted varied from a few years to over 30 years.

The biological parameters (growth and reproduction) were obtained from specific field studies conducted by individual shark biologists. The results formed the basis for specifying priors for life history parameters used in the model.

These data were appropriate sets of information to be applied to assessment models. It should be noted that the vital rate parameters were especially important in integrating biological knowledge about bonnethead productivity into the assessment.

While the estimated catch data are adequate for initial assessment analyses they suffer from the fact that they are relatively imprecise. This is translated into uncertainty in the assessment results.

Of the data sets, the CPUE and survey indices are most problematic. There was no strong basis for eliminating indices from the analysis (the Stock Assessment and Data Reviews addressed this previously). However, as mentioned, the spatial and temporal range of the indices varied considerably. Also, several indices purported to measure the same components of the population exhibited different trends. This is a common problem in assessments, but the implications are that as time proceeds and more index data are collected then some indices will become more reliable while others are eliminated from the analysis. This evolution may give a different picture of the dynamics of the stock in the future.

2. *Evaluate the adequacy, appropriateness, and application of methods used to assess the stock.*

The primary assessment method employed in the bonnethead assessment was a State-space, Age-structured Production Model (SPASM). The method used limited size frequency data to define time invariant selectivities for the indices and the catch by fishing sector. This was coupled with the prior distributions on productivity parameters translated into the stock-recruitment relationship. Then the population abundance (at reconstructed age) was projected forward from 1950 to the present such that the observed and predicted catches and index data were optimally fit using Maximum Likelihood criteria.

There are always alternative modeling approaches and the Stock Assessment Panel considered Bayesian surplus production models as another option. However, this option was rejected on several grounds (symmetry of the surplus production curve is not consistent with understanding of the life history information; SPASM allows age specific mortality and reproduction data to be used). Also, a Bayesian surplus production model of the small coastal complex was examined, the results of which would encompass bonnethead dynamics as part of the aggregate.

Perhaps, other alternatives could have been explored (e.g. fitting the model to the selectivity size frequency data directly). However, it is unclear that this approach would be any better. Additionally, all of these modeling options suffer from the same problem mentioned above: that the indices are variable and inconsistent.

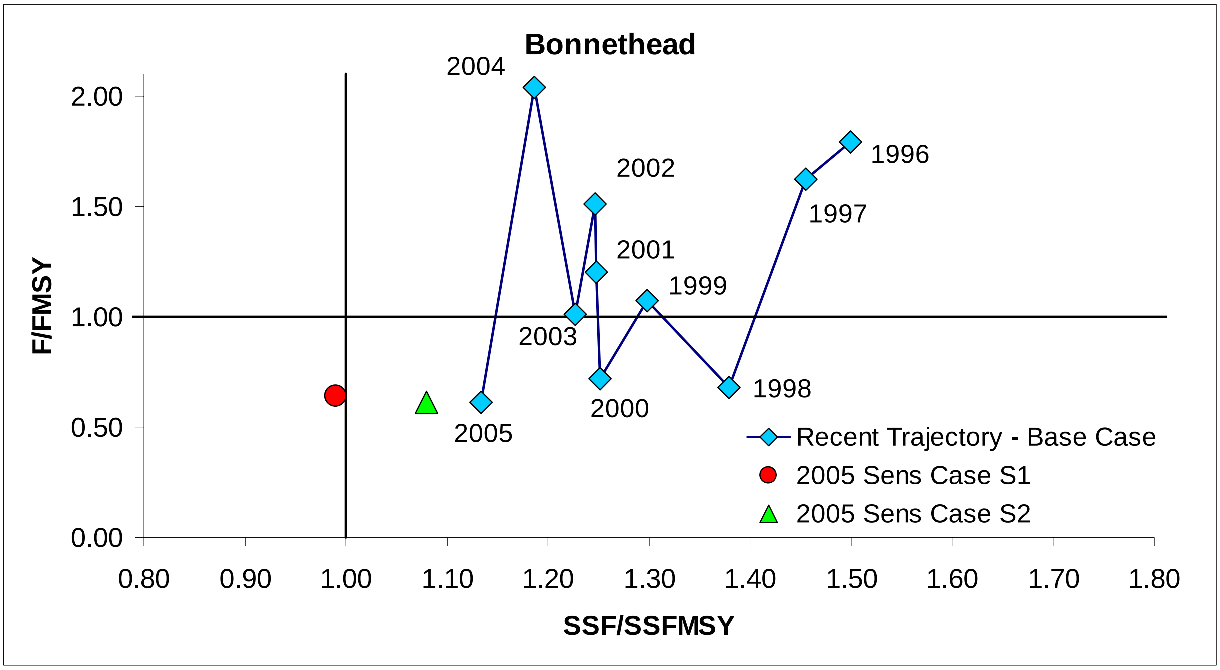
Therefore, it is the Review Panel's conclusion that the methods are appropriate to the application and, thus, are adequate. However, models cannot solve basic weaknesses in the data.

3. *Recommend appropriate estimates of stock abundance, biomass, and exploitation (if possible).*

The base case assessment produced estimates of the number of animals (N), the number of mature females pup production (SSF), the fishing mortality rates throughout the time series (1950-2005). The estimates for the current (2005) statistics are given 1.59 million , 2.26 million and 0.19, respectively. Additionally, two sensitivity tests were conducted, one which used inverse variance weighting of the indices; and the other used all the indices included plus those rejected in the base case. The result of these tests (including the base case) showed a range in N of 1.13 to 1.59 million and the range in SSF of 1.97 to 2.26 million.

4. *Evaluate the methods used to estimate population benchmarks and management parameters; recommend values for management benchmarks (MSY, Fmsy, Bmsy, MSST, MFMT) and provide declarations of stock status*

The methods used to estimate stock status were appropriate for the population model used in the assessment. They allowed the Review Panel to test the impact of alternatives assumptions about the data on the status of the stock.



Note that the estimates of annual fishing mortality rates (Figure above) exhibit considerable annual variability. This probably occurs for two reasons: 1) the major source of fishing mortality for bonnethead is the shrimp trawl bycatch fishery. Since this does not direct at bonnethead shark, catches (and mortality rates) vary from year to year depending on the distribution of bonnethead sharks relative to the shrimp. Therefore, more annual variability in F than normally occurs in directed fisheries is expected; and 2) due to the assessment method (and data), variability in F is probably overestimated, i.e. uncertainties in the model fits are shifted to variability in F. For these reasons, the Review Panel recommends that the $F_{current}/F_{msy}$ metric use a more stable estimate of $F_{current}$ (in the assessment documents $F_{current}$ equals the F in the year 2005). F 2005 is less than F_{msy}, while in the previous ten years the F's varied both above and below F_{msy}. This should be considered when determining the overfishing status.

The current assessment indicates that there is a preponderance of probability that SSF is greater than SSF_{msy}, i.e. that bonnethead sharks are not overfished. The estimate of fishing mortality rate in 2005 is less than F_{msy}, thus there was no overfishing in that year. However, fishing mortality rates in the recent past have fluctuated above and below F_{msy}. Thus, there is some probability that fishing mortality rates in 2006 and 2007 have been in excess of F_{msy}.

5. *Evaluate the adequacy, appropriateness, and application of methods used to project future population status; recommend appropriate estimates of future stock condition (if possible).*

Since the recent fishing mortality rates have fluctuated around F_{msy}, a projection was conducted in which fishing mortality rates in the future were kept at the average of F in the last ten years. Long term projections showed that the median SSF under these conditions remained slightly higher than SSF_{msy}. However, there was some probability that SSF will fall below SSF_{msy} in the future, if current average F's are maintained.

While the projection methodology is adequate for predicting point estimates of future status, it does not characterize all of the uncertainty in the assessment carried through to the projections. Therefore, probability statements about future status are not very precise.

6. *Evaluate the adequacy, appropriateness, and application of methods used to characterize uncertainty, considering input data, model fit, and model configuration. Ensure that the implications of uncertainty with regard to status determinations and management values are clearly stated.*

As in all modeling exercises, estimates of uncertainty are conditional on the structure of the model. Often in these circumstances, uncertainty (variance) is underestimated. This appears to be especially so with bonnethead sharks. The statistical estimates of variation emanating from the fits to the catch and survey indices, depend upon a number of structural assumptions. Given the state of the data, there were no better alternatives. However, when interpreting the probability distributions of status, it is expected that there are higher probabilities in the tails; i.e. that the stock is much better or much poorer than indicated by the analysis.

7. *Ensure that the assessment results are clearly and accurately presented in the Stock Assessment Report and that the reported results are consistent with Review Panel recommendations.*

See Section 2.2.2, above

8. *Evaluate the SEDAR Process. Identify any Terms of Reference which were inadequately addressed by the Data or Assessment Workshops; identify any additional information or assistance which will improve Review Workshops; suggest improvements or identify aspects requiring clarification.*

See Section 2.2.2, above

9. *Consider the research recommendations provided by the Data and Assessment workshops and make any additional recommendations warranted. Clearly indicate the research and monitoring needs that may appreciably improve the reliability of future assessments. Recommend an appropriate interval for the next assessment and whether a benchmark or update assessment should be considered.*

Research recommendations from the Data Workshop Report relevant to bonnethead sharks are given above in the general research recommendation section.

Schedule for the next assessment of bonnethead: the current stock status indicates that it is not overfished. While in 2005 it was not undergoing overfishing, in several of the previous years it had been. Thus, it would be wise to reassess this stock within two or three years. However, major differences in the status are unlikely to be detected unless, 1) regulations are implemented; 2) data and indices are improved or consistent subsets of stock size indices are used; or 3) catches change.

3.0 Recommendations for future SEDAR assessments

Participants and the Review Panel commented throughout the week on the SEDAR assessment process. What follows is a non-prioritized list of the points made:

Sensitivity runs in the assessments should examine the robustness of stock status relative to the biological parameters that determine MSY. These include values for M, growth fecundity selectivity and the form of the stock recruitment curve.

Projection software tools should be developed that can incorporate uncertainty in the initial conditions and capture process error more comprehensively for the forecast period.

The Review workshop identified process error, especially in F, as a problem in determining stock status relative to MSY reference points. Further consideration needs to be given to a more robust means of interpreting stock status than the procedure of simply using the most recent data year. It is also important for managers to know the probability of exceeding reference points in the medium term, even if present stock status is judged satisfactory.

A more detailed and comprehensive analysis of the CPUE series would be desirable to evaluate the utility of many series available. A rigorous and objective scientific protocol should be developed against which CPUE series are evaluated as a basis for inclusion in assessments. This should include, *inter alia*, statistical design, spatial coverage and relevance to target species. The Review Panel envisioned a set of standards that delineated a weighted scoring depending on the attributes of the time series. For example, if the time series was based on a statistically valid sampling design targeted at the specific species, then it would achieve a high score for that standard. If the time series was properly designed for another species and largely covered the distribution in space and time, it would achieve an intermediate score against this standard, and so on. This would avoid vulnerability to personal preference and ad hoc choice of time series to include.

Differences between successive assessments, particularly when different data series or different assessment models are used, should be systematically investigated to assess whether differences are due to changes in data, changes in models, or changes in assumptions.

4.0 Reviewer Statements

The Consensus Report provides an accurate summary of my views on the issues covered in the review. Joseph Powers, Robin Cook, Cynthia Jones, J.-J. Maguire